(19) Japan Patent Office (JP)

(12) Japanese Laid-open Application (A)

(11) Japanese Laid-open Application No. 2001-78260 (P2001-78260A)

(43) Japanese Laid-open Application Date: March 23, 2001 (2001. 3. 23)

(51) Int. Cl.[7]	ID Code	FI	Theme Code (Reference)
H 04 Q 7/38		H 04 B 7/26	109 K 5 K 019
H 04 M 1/677		H 04 M 1/677	5 K 027
3/00		3/00	D 5 K 051
3/36		3/36	B 5 K 067
		H 04 B 7/26	109 G

Request for Examination: Yes
Number of claims: 16 OL
Total pages: 13 (Continued to the last page)

(21) Patent Application No.: H11-251813

(22) Filing Date: September, 6, 1999 (1999. 9. 6)

Applied in accordance with Article 30, paragraph 1 of the Patent Law. Published in "1999 Electronics, Information and Communication Engineers Society General Meeting Lecture Collected Papers 1" published by The Institute of Electronics, Information and Communication Engineers (IEICE)

(71) Applicant: 399004577
YRP Kokino Idotai Tsushin Kenkyujo K.K.
3-2 Hikarinooka, Yokosuka City, Kanagawa Prefecture

(72) Inventor: Hirotake Wakai
c/o YRP Kokino Idotai Tsushin Kenkyujo K.K.
3-2 Hikarinooka, Yokosuka City, Kanagawa Prefecture

(74) Agent: 100105500
Yoshitaka Takeyama, Patent Attorney (and 3 others)

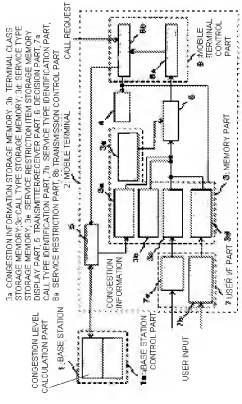
(Continued to the last page)

(54) [Title of the Invention] CONGESTION CONTROL METHOD IN MOBILE COMMUNICATION SYSTEM, MOBILE TERMINAL AND BASE STATION

(57) [Abstract]

[Problems to be Solved] To provide a congestion control method in a mobile communication system in which a call can be made depending on the type of communication services even in the congested state.

[Solution] A base station always monitors the congestion state of a radio zone, calculates congestion levels and informs a mobile terminal 2 of them as congestion information. The mobile terminal 2 restricts calls in response to congestion levels and types of communication services or by adding the priority of calls to them. A memory part 3 has a congestion information storage memory 3a, a terminal class storage memory 3b, a call type storage memory 3c, a service type storage memory 3d storing the types of communication service functions such as voice communication, short messages, image communication, etc., a service restriction storage memory 3e and the like.



[What is claimed is]

[Claim 1] A congestion control method in a mobile communication system comprising one or more of mobile terminals in a radio zone covered by a base station, wherein the mobile terminals communicate with the base station or among themselves, and wherein:

the base station monitors the congestion state and notifies the mobile terminals of congestion information; and

the mobile terminals receive the congestion information from the base station, input at least the congestion information and the types of communication services for call request and restrict transmission based on the restriction standards of communication services.

[Claim 2] The congestion control method in the mobile communication system according to Claim 1, wherein the congestion information is created based on the total number of the communication mobile terminals or call setup processing.

[Claim 3] The congestion control method in the mobile communication system according to Claim 1, wherein one or more of deterioration decision threshold values are set, and wherein the congestion information is created in accordance with the least deterioration decision threshold value when the number of deterioration decisions where a loss-call rate within a predetermined measuring time deteriorates more than the deterioration decision threshold values is within a predetermined upper limit value during a predetermined decision period.

[Claim 4] A mobile terminal in a mobile communication system comprising one or more of mobile terminals in a radio zone covered by a base station, wherein the mobile terminals communicate with the base station or among themselves, the mobile terminal comprising:

a reception means of receiving the congestion information from the base station;

an input means of inputting the types of communication services for call request; and

a service restriction decision means of restricting transmission based on communication service restriction standards using at least the congestion information and the types of communication services as input conditions.

[Claim 5] The mobile terminal according to Claim 4, wherein the input conditions comprises the priority of calls.

[Claim 6] The mobile terminal according to Claim 5, wherein the priority of calls is decided based on the type of call request and the terminal class of the mobile terminal.

[Claim 7] The mobile terminal according to any one of Claims 4-6 comprising a service restriction item storage memory storing the types of services whose transmission is restricted or the types of services whose transmission is not restricted, wherein the service restriction decision means restricts transmission by reading out the service restriction item storage memory in accordance with the input conditions.

[Claim 8] The mobile terminal according to any one of Claims 4-6, wherein the congestion information comprises multiple steps of congestion levels, and wherein the service restriction decision means restricts transmission starting with the communication service that is susceptible to congestion in response to an increased congestion level.

[Claim 9] The mobile terminal according to any one of Claims 4-6, wherein the congestion information comprises multiple steps of congestion levels, and wherein the service restriction decision means restricts transmission starting with the lowest priority of calls in response to an increased congestion level.

[Claim 10] The mobile terminal in a mobile communication system according to any one of Claims 4-6, wherein the congestion information comprises multiple steps of congestion levels, and wherein the service restriction decision means restricts transmission based on the susceptibility of the communication service to congestion and the priority of calls in response to an increased congestion level.

[Claim 11] The mobile terminal according to any one of Claims 4-10, wherein the congestion information comprises multiple steps of congestion levels, and wherein the service restriction decision means does not restrict the transmission of short message communication services regardless of the congestion levels.

[Claim 12] The mobile terminal according to any one of Claims 4-11, wherein the congestion information comprises multiple steps of congestion levels, and wherein the service restriction decision means restricts voice communication services in response to the congestion levels.

[Claim 13] The mobile terminal according to any one of Claims 4-12, wherein the congestion information comprises multiple steps of congestion levels, and wherein the service restriction decision means restricts image communication services in response to the congestion levels.

[Claim 14] A congestion control method in a mobile communication system comprising one or more of mobile terminals in a radio zone covered by a base station, wherein the mobile terminals communicate with the base station or among themselves, and wherein the base station monitors the congestion state and, when the mobile terminal makes a call, forcibly disconnects the communication of a communicating mobile terminal if the congestion state is above a predetermined level and the priority of calls by the mobile terminal that has made a call is higher than the priority of calls by the communicating mobile terminal in order to assign a communication channel to the mobile terminal that has made a call.

[Claim 15] A base station in a mobile communication system comprising one or more of mobile terminals in a radio zone covered by the base station, wherein the mobile terminals communicate with the base station or among themselves, the mobile terminal comprising:

a means of monitoring the congestion state;

a reception means of detecting a call from the mobile terminal;

a first terminal information storage means of storing the terminal information of the mobile terminal whose call has been detected;

a second terminal information storage means of storing the terminal information of the communicating mobile terminal;

a decision means of comparing the priority of calls between the communicating mobile terminal and the mobile terminal whose call has been detected based on the first and second terminal information if the congestion state is equal to or greater than a predetermined level; and

a control means of forcibly disconnecting the communication of the communicating mobile terminal and assigning a communication channel to the mobile terminal whose call has been detected when the priority of calls by the mobile terminals whose call has been detected is higher than the priority of calls by communicating mobile terminal.

[Claim 16] The base station in the mobile communication system according to Claim 15, wherein the priority of calls is decided based on the call type and/or the terminal class of the mobile terminal.

[Detailed Explanation of the Invention]

[0001]

[Field of the Invention] The present invention relates to congestion control methods, mobile terminals and a base station in a mobile communication system.

[0002]

[Prior Art] There has been an increased need for mobile communication lately. In the mobile communication system for business, there are only a few (about 5 or 6) call channels (service channels) within one radio zone (base zone) covered by one base station though the area of the radio zone is relatively wide. Accordingly, the congestion state tends to occur if a disaster, etc. occurs in a certain radio zone and there are many calls. There is therefore a need for constructing a network for preventing the service function of the system from declining at the time of congested calls because the mobile communication for business is used by users mainly related to public services.

[0003] Methods for setting up calls has conventionally been known that give priority to an emergency call within the radio zone of the mobile communication system at the time of congestion (See Japanese Laid-open Application No. H5-75536). Fig. 9 is a functional block diagram on the mobile terminal side explaining the congestion control method of a conventional mobile communication system. Fig 10 is a flow diagram explaining the operation of the conventional mobile terminal as shown in Fig. 9.

[0004] In Fig. 9, the reference numeral 41 is a dial receiver part for receiving a dial number inputted by a user. The reference numeral 42 is an emergency call number recording part for recording emergency call numbers such as a police station call number, a fire station call number and general call special numbers as a table. The reference numeral 43 is an emergency call identification part for comparing a received dial number with emergency call numbers recorded in the emergency call number recording part in order to identify an emergency call. The reference numeral 46 is a call type display recording part for inputting and recording an emergency call from the emergency call identification part and displaying the call type on a display part (not shown here). The reference numeral 5a is a receiver part for receiving restriction state information of a radio zone from a base station (not shown here). The reference numeral 44 is a restriction state recording part for recording the received restriction state information.

[0005] The reference numeral 45 is a transmission control part for carrying out transmission operation (call setup) as normal regardless of the call type if it is not in the restriction state by referring to the restriction state display recording part 44. When it is in the restriction state by referring to the restriction state display recording part 44, the transmission operation is prohibited if any emergency call is not identified by the emergency call identification part 43, or the transmission operation is carried out as normal despite the restriction state if an emergency call is identified. The reference numeral 5b is a transmitter part for starting control procedure for a call setup for a base station (not shown here).

[0006] A description of the operation of the conventional mobile terminal as shown in Fig. 9 is given below by referring to Fig. 10. First, the transmitter/receiver of a mobile terminal is off-hooked and a police station dial number (police station call number) is inputted. In S51, the dial receiver part 41 receives this dial number and records it in the dial recording part. Then, the process is moved on to S52. In the emergency call number recording part 42, an emergency call number table is stored in advance. In S52, the emergency call identification part 43 compares the dial number recorded in the dial number recording part with the emergency call numbers recorded in the abovementioned emergency call number table. Then, the process is moved on to S53.

[0007] If it is determined in S53 that the inputted dial number is an emergency call as a result of the comparison, the process is moved on to S54. If it is not an emergency call, the process is moved on to S55. If the dial number is a police station call number as described above, it agrees with one of emergency call numbers; therefore the process is moved on to S54. Data for displaying the emergency call is set in the call type display recording part 46, and the emergency is displayed on the display part. Then, the process is moved on to S57. If the dial number is a general call, the process is moved on to S55, and data for displaying the general call is set on the call type display recording part 46. Then, the process is moved on to S57.

[0008] Here, since the number of available call channels (service channels) is limited, the base station transmits restriction information to mobile terminals within its own radio zone if the number of calls increases. The restriction information transmitted from the base station is received by the receiver part 5a and recorded in the restriction state display recording part 44. In S56, the transmission control part 45 is activated to analyze the restriction state by determining if the restriction information is recorded in the call type display recording part 46 or not.

[0009] The transmission control part 45 moves the process to S57 if the restriction information is recorded in the restriction state display recording part 44. If no restriction information is recorded, the process is moved on to S61. In 57, the call type is identified by the emergency call identification part 43. Then, the process is moved on to S58. In S58, the transmission control part 45 moves the process to S61 if it is an emergency call. If it is not an emergency call, the process is moved on to S59. The terminal class display recording part records whether the mobile terminal is a general class or a priority class.

[0010] In S59, the transmission control part 45 identifies the terminal class by reading out the terminal class display recording part. Then, the process is moved on to S60. In S60, the transmission control part 45 moves the process to S61 if it is a priority class. If it is a general class, the process is moved on to S62. In S62 where the process is moved from S56 or S60, the transmission control part 45 carries out transmission processing by sending out a dial number to the transmitter part 5b. Or, in S62, the transmission control part 45 carries out restriction processing in order not to allow sending the dial number to the transmitter part 5b. Thus, the process is moved on to S63, and the system notifies the user of the restriction by generating a restriction tone from the ear receiver.

[0011] As a result, the process is moved on to S61 directly from S57 and S58 if the dial number is the police call number. Therefore, even a general mobile terminal can be handled in the same manner as a priority class, and the transmission processing and the subsequent call setup are preferentially carried out in S61. If it is not an emergency call, the terminal class is identified in S58 and S59. As a result, the general call from a general class mobile terminal is restricted, and a restriction tone is sent out.

[0012] As described above, an emergency call can be made from a general class mobile terminal even if the communication network is congested and transmission restricted within the radio zone covered by one base station. However, the transmission of all the low priority calls (e.g., general calls from general class mobile terminals) is restricted such that no communication is possible for users. There is therefore a need for providing a minimum of communication services to users even in the congestion state, thereby preventing a decline in the service function of the communication services. There is also a need for securing highly preferential communication by allowing for the call setup if there occurs a highly preferential call even in the congestion state, thereby preventing a decline in the service function of the communication services.

[0013]

[Problems that the Invention is to Solve] The present invention was made to solve the abovementioned problems. The object of the invention is to provide congestion control methods in a mobile communication system that allows for a call depending on the type of communication services even in the congestion state as well as a mobile terminal. Moreover, the object of the invention is to provide congestion control methods in a mobile communication system that allows securing the communication of a highly preferential call even in the congestion state as well as a base station.

[0014]

[Means of Solving the Problems] In the invention according to Claim 1, the present invention provides a congestion control method in a mobile communication system having one or more of mobile terminals in a radio zone covered by a base station, wherein the mobile terminals communicate with the base station or among themselves, and wherein: the base station monitors the congestion state and notifies the mobile terminals of congestion information; and the mobile terminals receive the congestion information from the base station, input at least the congestion information and the types of communication services for call request and restrict transmission based on the restriction standards of communication services. Accordingly, it is possible to decide whether transmission is allowed or restricted by the type of communication services depending on the congestion state. Communication time is decided by and large depending on the type of communication services. Accordingly, a minimum of communication services can be provided by deciding the communication services that can be transmitted in light of the congestion state. Moreover, since transmission is restricted depending on the congestion state, an increased volume of calls can be prevented in a communication network, thereby avoiding any aggravation of the congestion state in the communication network.

[0015] As for the invention according to Claim 2, in the congestion control method in the mobile communication system according to Claim 1, the congestion information is created based on the total number of the communicating mobile terminals or call setup processing. Accordingly, the congestion state can easily be found based on the abovementioned congestion information.

[0016] As for the invention according to Claim 3, in the congestion control method in the mobile communication system according to Claim 1, one or more of deterioration decision threshold values are set, and the congestion information is created in accordance with the least deterioration decision threshold value when the number of deterioration decisions where a loss-call rate within a predetermined measuring time deteriorates more than the deterioration decision threshold values is within a predetermined upper limit value during a predetermined decision period. Accordingly, the congestion state can accurately be found based on the abovementioned congestion information.

[0017] The invention according to Claim 4 provides a mobile terminal

terminals in a radio zone covered by a base station, wherein the mobile terminals communicate with the base station or among themselves, the mobile terminal having a reception means of receiving the congestion information from the base station, an input means of inputting the types of communication services for call request; and a service restriction decision means of restricting transmission based on communication service restriction standards using at least the congestion information and the types of communication services as input conditions. Accordingly, it is possible to decide whether transmission is allowed or restricted by the type of communication services depending on the congestion state.

[0018] As for the invention according to Claim 5, in the mobile terminal in the mobile communication system according to Claim 4, the input conditions include the priority of calls. Accordingly, communication services whose transmission should be restricted can be changed by the priority of calls depending on the congestion state.

[0019] As for the invention according to Claim 6, in the mobile terminal in the mobile communication system according to Claim 5, the priority of calls is decided based on the type of call request and the terminal class of the mobile terminal. Accordingly, communication services whose transmission should be restricted can also be changed by the type of call request and/or the terminal class of the mobile terminal depending on the congestion state.

[0020] As for the invention according to Claim 7, the mobile terminal according to any one of Claims 4-6 has a service restriction item storage memory storing the types of services whose transmission is restricted or the types of services whose transmission is not restricted, wherein the service restriction decision means restricts transmission by reading out the service restriction item storage memory in accordance with the input conditions. Accordingly, the service restriction standards to be decided in accordance with the input conditions can easily be set and referenced.

[0021] As for the invention according to Claim 8, in the mobile terminal in the mobile communication system according to any one of Claims 4-6, the congestion information has multiple steps of congestion levels, and the service restriction decision means restricts transmission starting with the communication service that is susceptible to congestion in response to an increased congestion level. Accordingly, an increased volume of a communication network can effectively be prevented. As a result, it is possible to avoid the aggravation of the congestion state in the communication network.

[0022] As for the invention according to Claim 9, in the mobile terminal in the mobile communication system according to any one of Claims 4-6, the congestion information has multiple steps of congestion levels, and the service restriction decision means restricts transmission starting with the lowest priority of calls in response to an increased congestion level. Accordingly, an increased volume of a communication network can be prevented while considering the priority of calls. As a result, it is possible to

in a mobile communication system having one or more of mobile

avoid the aggravation of the congestion state in the communication network.

[0023] As for the invention according to Claim 10, in the mobile terminal according to any one of Claims 4-6, the congestion information has multiple steps of congestion levels, and the service restriction decision means restricts transmission based on the susceptibility of the communication service to congestion and the priority of calls in response to an increased congestion level. Accordingly, an increased volume of a communication network can effectively be prevented while considering the priority of calls. As a result, it is possible to avoid the aggravation of the congestion state in the communication network.

[0024] As for the invention according to Claim 11, in the mobile terminal according to any one of Claims 4-10, the congestion information has multiple steps of congestion levels, and the service restriction decision means does not restrict the transmission of short message communication services regardless of the congestion levels. A minimum of communication services can be provided for short message communication because a communication time is relatively short. An increased volume of calls can be prevented in a communication network as well.

[0025] As for the invention according to Claim 12, in the mobile terminal according to any one of Claims 4-11, the congestion information has multiple steps of congestion levels, and the service restriction decision means restricts voice communication services in response to the congestion levels. Since voice communication services require a certain length of communication time and have a high frequency in use, an increased volume of calls can effectively be prevented in a communication network by restricting transmission depending on the congestion level. As a result, it is possible to avoid the aggravation of the congestion state in the communication network.

[0026] As for the invention according to Claim 13, in the mobile terminal according to any one of Claims 4-12, the congestion information has multiple steps of congestion levels, and the service restriction decision means restricts image communication services in response to the congestion levels. Since image communication services require a long communication time, an increased volume of calls can effectively be prevented in a communication network by restricting transmission depending on the congestion level. As a result, it is possible to avoid the aggravation of the congestion state in the communication network.

[0027] The invention according to Claim 14 provides a congestion control method in a mobile communication having one or more of mobile terminals in a radio zone covered by a base station, wherein the mobile terminals communicate with the base station or among themselves, and wherein the base station monitors the congestion state and, when the mobile terminal makes a call, forcibly disconnects the communication of a communicating mobile terminal if the congestion state is above a predetermined level and the priority of calls by the mobile terminal that has made a call is higher than the priority of calls by the communicating mobile terminal in order to assign a communication channel to the mobile

terminal that has made a call. Accordingly, it is possible to secure the communication of a highly preferential call even when the congestion level is above a predetermined level. Any call-loss of a highly preferential call can therefore be avoided.

[0028] The invention according to Claim 15 provides a base station in a mobile communication system having one or more of mobile terminals in a radio zone covered by the base station, wherein the mobile terminals communicate with the base station or among themselves, the mobile terminal having a means of monitoring the congestion state, a reception means of detecting a call from the mobile terminal, a first terminal information storage means of storing the terminal information of the mobile terminal whose call has been detected, a second terminal information storage means of storing the terminal information of the communicating mobile terminal, a decision means of comparing the priority of calls between the communicating mobile terminal and the mobile terminal whose call has been detected based on the first and second terminal information if the congestion state is equal to or greater than a predetermined level and a control means of forcibly disconnecting the communication of the communicating mobile terminal and assigning a communication channel to the mobile terminal whose call has been detected when the priority of calls by the mobile terminals whose call has been detected is higher than the priority of calls by the communicating mobile terminal. Accordingly, it is possible to secure the communication of a highly preferential call even when the congestion level is above a predetermined level. Any call-loss of a highly preferential call can therefore be avoided.

[0029] As for the invention according to Claim 16, in the base station in the mobile communication system according to Claim 15, the priority of calls is decided based on the call type and/or the terminal class of the mobile terminal. Accordingly, it is possible to secure communication depending on the call type and/or the terminal class of a mobile terminal even in the congestion state.

[0030]

[Mode for Implementing the Invention] Fig. 1 is a block diagram explaining First Embodiment according to the present invention. The system connecting between a base station 1 and a mobile terminal 2 is called the no-delay system. Accordingly, a call setup is possible only when there is an available communication channel (service channel). If there is no available channel, a call is discarded without waiting. Algorism is such that channels are assigned by the priority of calls. The priority of calls is decided by the priority of call contents such as a general call and an emergency call and/or the priority of terminal classes of mobile terminals. If it is decided by a combination of both ways, there are two methods. The first method is one for setting priority levels based on combinations. The second method is one for setting priority levels individually and then combining those priority levels. The latter method is used for deciding the priority of calls in First Embodiment.

[0031] The base station always monitors the congestion state in the radio zone, calculates the congestion level and notifies the mobile terminal 2 of the congestion level as congestion information. On the other hand, the mobile terminal 2 carries out communication restriction (call restriction) depending on the congestion level and the type of communication services or by adding the priority of calls to them. Or, the base station 1 may transmit data obtained by monitoring the congestion state to the mobile terminal 2 as congestion information and the mobile terminal 2 calculate the congestion level based on the monitored data.

[0032] The reference numeral 1a is a base station control part that calculates the congestion level and transmits the congestion information to the mobile terminal 2 via a transmitter part (not shown here). The mobile terminal 2 has a memory part 3, a display part 4, a transmitter/receiver part 5, a comparison part 6, a user I/F (user interface) part 7 and a mobile terminal control part 8. We omit the illustration and explanation of a baseband part used for processing call information (user data), a modem part, a front end part, etc.

[0033] The transmitter/receiver part 5 transmits and receives not only call information (user data) but also control information, congestion information and the like. The memory part 3 has a congestion information storage memory 3a for storing the congestion level transmitted from the base station 1 via the transmitter/receiver part 5, a terminal class storage memory 3b for storing terminal classes such as general classes and priority classes of the mobile terminal 2 fixedly assigned at the time of shipment from the factory, a call type storage memory 3c for storing call types such as a emergency call inputted by a user via the user I/F part at the time of a call request, a service type storage memory 3d for similarly storing the types of communication service functions such as voice communication, short messages and image communication inputted by a user via the user I/F part at the time of a call request and a service restriction item storage memory 3e that is preset for a mobile terminal at the time of shipment from the factory and will be described below by referring to Fig. 4.

[0034] Mobile terminals classified as the priority class include those used by special users who preferentially need communication at the time of a disaster. For the same reason, dial numbers for emergency calls include those for fire stations, police stations and the like. Service types include voice communication, short message communication, dynamic image communication, still image communication, facsimile communication and other data communication. A description of three types of communication services (voices, short messages and (still) images) is given below as examples. As used herein, the short message communication refers to character messages that are restricted in the number of characters including set expressions and free expressions.

[0035] Each functional block as described above is executed by controlling such hardware as the input I/F part 7, the display part 4 and the transmitter/receiver part 5 using an RAM (Random Access Memory) based on a CPU (Central Processing Unit) operated by control programs stored in a ROM (Read Only Memory). RAMs may be used for the abovementioned congestion information storage memory 3a, call type storage memory 3c and service type storage memory 3d. The storage contents of the service restriction item storage memory 3e and the terminal class storage memory 3b are written at the time of shipment from the factory using a

ROM (e.g., Electrically Erasable and Programmable Read Only Memory, or EEPROM) and may be rewritten by a system administrator after shipment.

[0036] A call type identification part 7a within the user I/F part 7 identifies the call type from a dial number inputted by a user using a push button dial or the like and writes the call type into the call type storage memory 3c. A service type identification part 7b within the user I/F part 7 identifies the service type inputted by a user using a service mode button or the like and writes this into the service type storage memory 3d.

[0037] A decision part 6 inputs the contents stored in the congestion information storage memory 3a, the terminal class storage memory 3b and the call type storage memory 3c, decides whether or not communication services should be permitted for the call type and service type of a dial number inputted by a user based on the service restriction standards in the current congestion state according to the terminal class of the user's mobile terminal and then outputs the result of decision to a service restriction part 8a. If the transmission service should be restricted, the service restriction part 8a controls a transmission control part 8b such that no transmission can be carried out even when there is a call request. If the communication service should not be restricted, it allows the transmission control part 8b to make a call setup for a sender of the dial number inputted by the call request. A display part 4 displays the service type, congestion state, transmission restriction state, etc. stored in the memory 3 as needed and audio-displays by generating a restriction tone.

[0038] Fig. 2 is a functional block diagram of a mobile terminal explaining the operation of First Embodiment according to the present invention. In the drawing, the same parts as those in Fig. 1 and Fig. 9 are indicated by the same reference numerals, and the explanation is omitted. Fig. 3 is a flow diagram on the mobile terminal side explaining the operation of First Embodiment according to the present invention. Fig. 4 is an explanatory view showing the contents of the service restriction item storage memory as shown in Fig. 1 and Fig. 2.

[0039] A description of the operation is given below by referring to the flow diagram in Fig. 3 together with other drawings. First, when a user's call request is detected by off-hook operation or the like, a call type from the call type identification part 7a and a service type from the service type identification part 7b are stored in the call type storage memory 3c and the service type storage memory 3d, respectively, in S11. At the same time, call type information such as emergency and general is displayed on a call type display part 4a of the display 4. Then, the process is moved on to S12.

[0040] Such congestion information as the congestion level timely notified from the base station control part 1a is received at the receiver part 5a. The congestion information stored in the congestion information storage memory 3a is updated successively. Although there are many methods for calculating the congestion level, a description of two methods is given below.

[0041] In the first method, the system monitors the total number of communicating mobile terminals or call setup processing within the radio zone at a given time. The congestion level is calculated based on the total number. In the second method, one or multiple deterioration decision threshold values B_k is set in advance. The call-loss rate is measured for each of the deterioration decision thresholds B_k within a predetermined measuring time T_0, and the deterioration decision number is indicated as 1 when the call-loss rate deteriorates below each of the deterioration decision thresholds B_K. This calculation is conducted for a predetermined decision period T_1 that is longer than the time T_0 to find the number of deterioration decision times. The congestion level is calculated based on the smallest value of the deterioration decision threshold values B_K when the number of deterioration decision times is within a predetermined upper limit value n. The call-loss rate may be a value found by dividing the number of calls, which were made to a base station from mobile terminals within the radio zone yet were not connected for communication because no call channel (service channel) was assigned, by the total number of communication channels.

[0042] Let us use specific values for explanation. Suppose B_1 = 30%, B_2 = 40% and B_3 = 50% when T_0 = 10 seconds, T_1 = 2 minutes and n = 5 times. The congestion level is 0 if n = 5 times or less when B_1 = 30%. Moreover, congestion level is 1 if n = 5 times or less only when B = 40%. Furthermore, congestion level is 2 if n = 5 times or less only when B = 50%. The congestion level is 3 if n = 5 times or less does not occur even when B = 50%. As used herein, the congestion level 0 shows the lowest level of congestion including the state in which there is no congestion at all. The congestion level 3 shows the most congested state.

[0043] In S 12, the congestion state is analyzed by reading the congestion level stored in the congestion information storage memory 3a and outputs the congestion level to the decision part 6 and a congestion level display part 4c. Then, the process is moved on to S13. The congestion level display part 4c notifies a user of the congestion level using such numbers as 0, 1, 2 and 3. In S13, the decision part 6 inputs the call type, service type and terminal class of a call currently requested by the user that are stored in the call type storage memory 3c, the service type storage memory 3d and the terminal class storage memory 3b, respectively, as well as the congestion level of the current communication network and decides whether or not the requested communication services should be restricted by referring to a service restriction item table stored in the service restriction item storage memory 3e as decision standards. Then, the process is moved on to S14.

[0044] Fig. 4(a) and Fig. 4 (b) are explanatory views showing whether the service is available (transmission processing) or prohibited (transmission restriction) when the terminal class is "the priority class" and "the general class," respectively. Such decision standards are stored in the service restriction item storage memory 3e in the form of a reference table. For example, an address is designated based on the call type, the terminal type and the congestion type; and one or multiple service types that are restricted in transmission are stored in the address. Then, it is determined if the service type of a requested call agrees with the service types read from the service restriction item storage memory 3e or not. Conversely, the service types that are not restricted may be stored in the service restriction item storage memory 3e or both those that are restricted and those that are not restricted may be stored separately.

[0045] As the basic idea of communication service restriction, transmission is restricted by the service type depending on the congestion level. As the congestion level increases, transmission is restricted starting with a communication service that is susceptible to congestion and requires a long communication time (holding time) because of a large volume of information.

[0046] In the example as shown in Fig. 4 (a), if the terminal class is in the priority class and a general call, transmission is restricted for the voice communication services only when the congestion level is the highest level 3. Transmission is restricted for the image communication services when the congestion level is 2 or higher. However, transmission is not restricted for short messages. On the other hand, if the terminal class is in the priority class and an emergency call, transmission is restricted only for image communication services when the congestion level is 2 or higher like a general call.

[0047] In the example as shown in Fig. 4 (b), if the terminal class is in the general class and a general call, transmission is restricted for the voice communication services when the congestion level is 2 or higher. Transmission is restricted for the image communication services when the congestion level is 1 or higher. No transmission is restricted for short messages regardless of the congestion level. On the other hand, the case in which the terminal class is in the general class and an emergency call is the same as the case in which the terminal class is in the priority class and an emergency call.

[0048] In the abovementioned examples, if the congestion level is high (e.g., the level 3), a call request made by a user from a mobile terminal that is even a general call can be accepted only when the communication services are for a short message whose information can be sent within a short communication time. In this manner, the communication services are available. In other words, users can secure a minimum of communication services.

[0049] If the congestion level is high (e.g., the level 3), the transmission of a general call is restricted for the voice communication services and image communication services. The transmission of an emergency call is restricted only for the image communication services. The short message communication service whose transmission is not restricted has a short communication time. Accordingly, the call-loss rate can be improved when the congestion level is high because there is no possibility that a call volume increases significantly. Thus, the congestion state can be avoided. Moreover, since a mobile terminal that newly makes a call uses the short message communication services, the number of mobile terminals available for communication can be increased.

[0050] Image communication that requires a large information volume and a long communication time tends to cause congestion more than the voice communication services do; therefore transmission is restricted on the lower congestion level. Hence, the aggregation of the congestion state can be avoided in advance in the communication networks. Moreover, in the abovementioned examples, communication services are provided in accordance with the priority of terminal classes. Therefore, if the terminal class is in the priority class, transmission is restricted for the voice communication services and image communication services on the one step higher congestion level than the general class. The transmission restriction is relaxed for an emergency call compared with a general call. Transmission is restricted only for the image communication services when the congestion level is 2 or higher.

[0051] In S14, the system gives directions to the service restriction part 8a as to whether or not services should be restricted depending on the results of decision. Then, the process is moved on to S15. In S15, the service restriction part 8a moves the process to S16 when services are not restricted or to S17 when services are restricted. In S16, the transmission control part 8b causes the transmitter part 5b to transmit a message to the base station for a call setup. On the other hand, in S17, the transmission control part 8b carries out the communication rejection processing and causes the transmission not permitted reason display part 4b to display a reason why transmission is not permitted. Then, the process is moved on to S18. For example, a message “all the communication channels are now in use” or the like is displayed when a call is requested for a low priority because the call type or terminal class is low in priority. In S18, a restriction tone showing that a call request is rejected is sounded from the ear receiver or the like of the mobile terminal 2.

[0052] Fig. 5 is a functional block diagram of a base station explaining Second Embodiment according to the present invention. In the drawing, the same parts as those in Fig. 1 are indicated by the same reference numerals, and the explanation is omitted. The reference numerals 21, 22, 23, 24, 25, 26, 27, 28, 29, 30 and 31 are a mobile terminal A, a mobile terminal B, a receiver part, a congestion level calculation part, a mobile terminal information read part, a communicating mobile terminal information storage memory, a decision part, a congestion level decision standards storage memory, a call priority comparison standards storage memory, a control information creation part and a transmitter part, respectively.

[0053] Each functional block as described above is executed by controlling such hardware as the receiver part 23 and the transmitter part 31 using an RAM (Random Access Memory) based on a CPU (Central Processing Unit) operated by control programs stored in a ROM (Read Only Memory). We omit the illustration and explanation of a baseband part used for processing call information (user data), a modem part, etc. Moreover, the base station 1 is connected to a public switched telephone network, etc. via a console, line control device or control station (not shown here).

[0054] Fig. 6 is an explanatory view of the storage contents of the congestion level decision standard storage memory as shown in Fig. 5. Fig. 7 is an explanatory view of the storage contents of the call priority decision standard storage memory as shown in Fig. 5. This embodiment shows a mode in which the mobile terminal A 21 and the mobile terminal B 22 communicate via the base station 1 or in which the mobile terminal A 21 communicates with a console or a subscriber to a public switched telephone network via the base station or a control station.

[0055] When a new call is received from a mobile terminal in the radio zone via a control channel in the congestion state, the base station compares the priority of calls between the multiple calls of currently communicating multiple mobile terminals and the new call made by the mobile terminal and, if the priority of calls of one of the currently communicating mobile terminals is lower, forcibly disconnects the currently communicating call whose priority is

lower in order to secure a call channel (service channel) and make a call setup for the new call whose priority is high.

[0056] In Fig. 5, at the timing of receiving a call, the receiver part 23 of the base station 1 receives mobile terminal information from the calling mobile terminal (e.g., the mobile terminal A 21). In general, mobile terminal information contains call types, terminal classes, service types, positional information, call information (user data) and so on. At the time of receiving the call, a call type and a terminal class are received. Also, the base station receives a terminal class from the other mobile terminal (e.g., the mobile terminal B 22) as mobile terminal information during a period between the completion of a call setup and communication connection.

[0057] The congestion level calculation part 24 calculates the congestion level by the method as described above by referring to Fig. 1 using information received from the receiver part 23 and outputs not only to a control information creation part 30 to create congestion information but also to a decision part 27 as described below. The mobile terminal information read part 25 reads a call type and a terminal class from the mobile terminal information received from the receiver part 23 and stores them. The communicating mobile terminal information storage memory 26 receives the call types and terminal classes of the mobile terminals A 21 and B 22 from the mobile terminal information read part 25 and stores them when the call setup of the mobile terminal that made a new call request is completed and communication permitted.

[0058] The call type of the mobile terminal B 22 that is the called side is adjusted to the call type of the mobile terminal A 21 that is the calling side. When multiple call channels (service channels) are being used, the communicating terminal information storage memory 26 stores the call types, terminal classes and the like of all the communicating mobile terminals. In the case of a mobile communication system in which the individual numbers of mobile terminals are registered in the control station connected to the base station 1, the registration of a terminal class together with an individual number only causes a need for notifying the base station of a individual number from a mobile terminal, thereby eliminating the need for transmitting the terminal class thereafter. The base station can find the terminal class from the individual number by asking to the control station.

[0059] As an example, suppose only the mobile terminal A 21 and mobile terminal B 22 are wirelessly communicating via the base station within the radio zone of the base station 1. The call type and terminal class of both the mobile terminal A 21 and mobile terminal B 22 are general calls and the general class, respectively. This information is stored in the communicating terminal information storage memory 26. Suppose a mobile terminal C of general class (not shown here) requests the base station 1 communication with the mobile terminal A 21 as an emergency call (call type). Then, the decision part 27 inputs the congestion level calculated at the congestion level calculation part 24 and decides whether to permit the forced disconnection of a low priority call based on the decision standards stored in the congestion level decision standards storage memory 28. The congestion level decision standards storage memory 28 creates an address based on the congestion level, for example, and reads out data specifying whether to permit the forced disconnection using the address.

[0060] As shown in Fig. 6, the forced disconnection is permitted when the congestion level is the level 1, 2 or 3. Next, the decision part 27 compares the priority of calls among mobile terminals by referring to the decision standards stored in the call priority comparison standards storage memory 29 based on the mobile terminal information of the mobile terminal C, which made a call, stored in the mobile terminal information read part 25 and the mobile terminal information of the mobile terminals A 21 and B 22 stored in the communicating mobile terminal information storage memory 26. If it is found, as a result of the comparison, that the priority of calls of the mobile terminal C is higher than the priority of calls of the mobile terminals A 21 and B 22, the decision part 27 causes the control signal creation part 30 to create a control signal used for forcibly disconnecting the call channel (service channel) between the mobile terminal A 21 and the mobile terminal B 22.

[0061] In the example as shown in Fig. 7, the call priority decision standards storage memory 29 outputs four levels (0-3) of the priority of calls depending on combinations of terminal classes and call types. That is, the priority of calls is the lowest level 0 when the combination is a general class and a general call. The priority of calls is the highest level 3 when the combination is a priority class and an emergency call. The level is 1 when it is a priority class and a general call. The level is 2 when it is a general class and an emergency call. The level may be 1 when it is a general class and an emergency call; and the level may be 2 when it is priority class and a general call. In the abovementioned example, the priority of calls of the mobile terminal C, which made a new call, is 2, and the priority of calls of the communicating mobile terminals A 21 and B 22 is 0. Therefore, the decision part 28 specifies forced disconnection.

[0062] When the party with whom the mobile terminal C requests communication is the mobile terminal A 21 as described above, comparison may be made with the priority of calls of the mobile terminal B 22 that is the current party communicating with the mobile terminal A 21 instead of the comparison with the priority of calls of the mobile terminal A 21 that is the party with whom the mobile terminal C requests communication. When the party with whom the mobile terminal C requests communication is the mobile terminal A 21, it is enough to compare the priority of calls of the mobile terminal C with the priority of calls of the mobile terminals A 21 and B 22 or the priority of calls of the mobile terminal B 22 even if there is a communicating mobile terminal other than the mobile terminals A 21 and B 22.

[0063] When receiving the specification of forced disconnection from the decision part 27, the control signal creation part 30 transmits a control signal for forcibly disconnecting connection to the mobile terminals A 21 and B 22 from the transmitter part 31 of the base station via a call channel or control channel. The mobile terminals A 21 and B 22 that have received the control signal will disconnect mutual communication. Subsequently, the base station 1 starts such a step for a call setup as enables the mobile terminal C and the mobile terminal A 21 to communicate with each other.

[0064] As described above, the possibility of the call-loss of high priority calls can be improved by allowing low priority calls to be forcibly disconnected. When low priority calls are communicating, the communicating channel can be assigned to a high priority call by forcibly disconnecting the communicating call even if all the call channels (service channels) are in use.

[0065] Fig. 8 is a functional block diagram of a base station explaining Third Embodiment according to the present invention. In the drawing, the same parts as those in Fig. 1 and Fig. 5 are indicated by the same reference numerals, and the explanation is omitted. This embodiment shows a mode in which the mobile terminals A 21 and B 22 transmit and receive call information (user data) mutually without going through the base station 1 after a call setup is complete.

[0066] When a new communication request is made from a mobile terminal within the radio zone in the congestion state, the base station 1 compares the priority of calls between the multiple calls of currently mutually communicating multiple mobile terminals and the new communication request made by the mobile terminal and, if the priority of calls of one of the currently mutually communicating mobile terminals is lower, forcibly disconnects the currently mutually communicating call whose priority is lower and make a call setup for the new communication request whose priority is high.

[0067] In such a mutually communicating mode, the receiver part 23 of the base station receives mobile terminal information such as the call types and terminal classes of mobile terminals from the mobile terminals A 21 and B 22. In this example, call information is directly transmitted or received between the mobile terminals without going through the base station. The congestion level calculation part 24 calculates the congestion level. The mobile terminal information read part 25 reads the call types and terminal classes of the mobile terminals A 21 and B 22 as well as a terminal C that has made a new call (not shown here) from the receiver part 23 and stores them. The communicating mobile terminal information storage memory 26 stores the call types, terminal classes, etc. of the mutually communicating mobile terminals.

[0068] The decision part 27 decides the congestion state and compares the priority of calls of the currently communicating multiple mobile terminals A 21 and B 22 with the priority of calls of a mobile terminal that has made a new communication request. The comparison operation is the same as that of Second Embodiment as described above by referring to Fig. 5, and therefore the explanation will be omitted. A forced disconnection signal created at the control signal creation part 30 is transmitted to the mutually communicating mobile terminals A 21 and B 22 from the transmitter part 31, and then the mobile terminals A 21 and B 22 disconnect the mutual communication. Subsequently, the base station 1 starts such a step for a call setup as enables the mobile terminal C and the mobile terminal A 21 to communicate with each other.

[0069] Even when the communication mode via a base station as shown in Fig. 5 and the mutual communication mode without going through a base station as shown in Fig. 8 are mixed, it is possible to forcibly disconnect the communication of a low priority call and make a call setup for a newly requested call in either communication mode in the same manner by comparing the priority of calls of currently communicating mobile terminals with the priority of calls of the newly requested call.

[0070] If currently communicating communication services are short message communication services, those services may not be covered by forced disconnection because short message communication services are the smallest communication services. Moreover, the congestion level required for forced disconnection may be lowered for service types that are susceptible to congestion.

[0071] The abovementioned description that was made for the mobile communication system for business may be applied to the public mobile communication system as well. A wide variety of multiple access systems have been known as mobile communication systems including FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access). However, the present invention is not limited to any particular multiple access system.

[0072]

[Effect of the Invention] As described above, the present invention has the effect of making a call possible depending on the type of communication services even in the congestion state. As a result, it is possible to prevent a decline in the service function of the system by securing communication services that are not susceptible to congestion even if the communication network is in the congestion state and the priority of calls is low. Moreover, it is also possible to avoid the aggravation of congestion in the communication network by restricting transmission starting with the communication service that is susceptible to congestion depending on the congestion level. The invention allows restricting transmission meticulously when restricting transmission of communication services depending on the priority of calls based on congestion levels, call types, terminal classes, etc. and, therefore, has the effect of minimizing a decline in the service function of the mobile communication system in the congestion state. Moreover, the present invention has the effect of securing the communication of highly preferential calls even in the congestion state.

[Brief Description of the Drawings]

[Fig. 1] A block diagram explaining First Embodiment according to the present invention.

[Fig. 2] A functional block diagram of a mobile terminal explaining the operation of First Embodiment according to the present invention.

[Fig. 3] A flow diagram on the mobile terminal side explaining the operation of First Embodiment according to the present invention.

[Fig. 4] An explanatory view showing the contents of the service restriction item storage memory as shown in Fig. 1 and Fig. 2.

[Fig. 5] A functional block diagram of a base station explaining Second Embodiment according to the present invention.

[Fig. 6] An explanatory view of the storage contents of the congestion level decision standard storage memory as shown in Fig. 5.

[Fig. 7] An explanatory view of the storage contents of the call priority decision standard storage memory as shown in Fig. 5.

[Fig. 8] A functional block diagram of a base station explaining Third Embodiment according to the present invention.

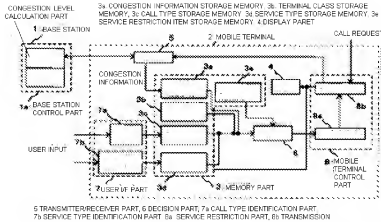
[Fig. 9] A functional block diagram on the mobile terminal side explaining a congestion control method for a conventional mobile communication system.

[Fig. 10] A flow diagram explaining the operation of the conventional mobile terminal as shown in Fig. 9.

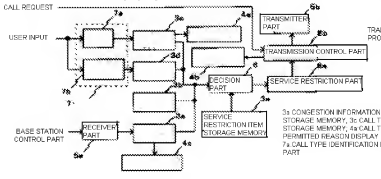
[Explanation of Reference Numerals]

1. Base station; 2. Mobile terminal; 3. Memory part; 4. Display part; 5. Transmitter/receiver part; 6. Decision part; 7. User I/F part; 8. Mobile terminal control part; 21. Mobile terminal A; 22. Mobile terminal B; 23. Receiver part; 24. Transmitter part; 25. Mobile terminal information read part; 26. Calling state terminal information storage memory; 27. Decision part; 28. Congestion level decision standard storage memory; 29. Call priority comparison standard memory; 30. Control information creation part; 31. Transmitter part.

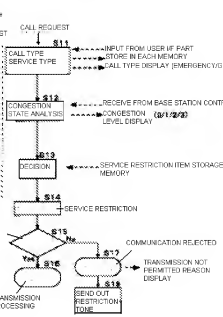
[Fig. 1]



[Fig. 2]



[Fig. 3]



[Fig. 4]

SERVICE ITEM	CALL TYPE / CONGESTION LEVEL	GENERAL CALL 0	1	2	3	EMERGENCY CALL 0	1	2	3
VOICE COMMUNICATION		○	○	×	×	○	○	○	○
SHORT MESSAGE		○	○	○	○	○	○	○	○
IMAGE COMMUNICATION		○	○	×	×	○	○	×	×

(a) TERMINAL CLASS: PRIORITY CLASS

[Fig. 6]

	CONGESTION LEVEL 0	1	2	3
FORCED DISCONNECTION OF LOW PRIORITY CALL	*	○	○	○

○: FORCED DISCONNECTION PERMITTED
×: FORCED DISCONNECTION PROHIBITED

[Fig. 7]

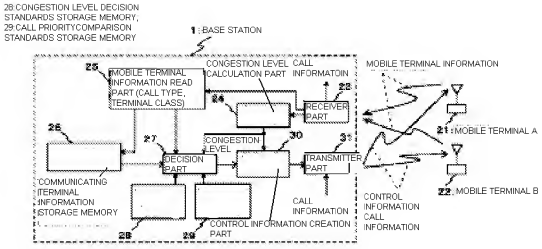
SERVICE ITEM	CALL TYPE / CONGESTION LEVEL	GENERAL CALL 0	1	2	3	EMERGENCY CALL 0	1	2	3
VOICE COMMUNICATION		○	○	×	×	○	○	○	○
SHORT MESSAGE		○	○	○	○	○	○	○	○
IMAGE COMMUNICATION		○	×	×	×	○	×	×	×

(b) TERMINAL CLASS: GENERAL CLASS

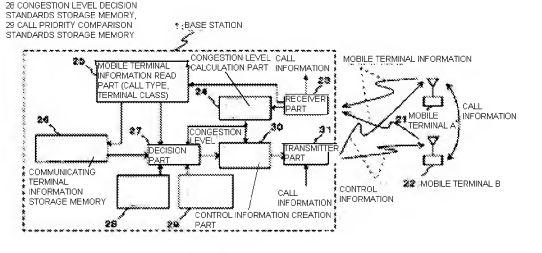
TERMINAL CLASS / CALL TYPE	CALL PRIORITY 0 GENERAL CLASS	1 GENERAL CALL	2 PRIORITY CLASS / TERMINAL CALL	3 GENERAL CLASS / EMERGENCY CALL	PRIORITY CLASS / EMERGENCY CALL

○: SERVICE USE PERMITTED
×: SERVICE USE PROHIBITED

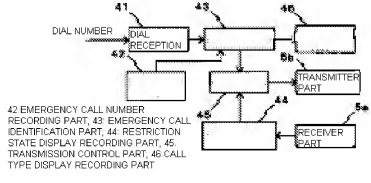
[Fig. 5]



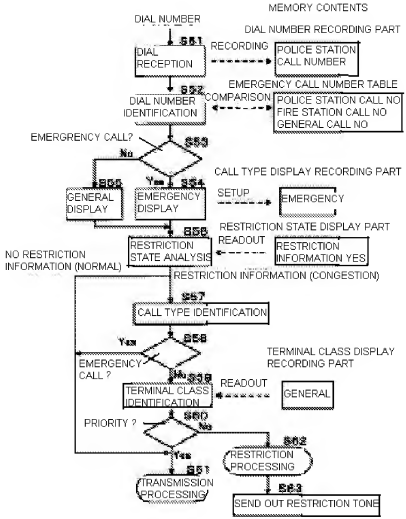
[Fig. 8]



[Fig. 9]



[Fig. 10]



(Continued from the front page)

(51) Int. Cl.[7]	ID Code	FI	Theme Code (Reference)
		H 04 Q 7/04	D

F Term (Reference) 5K019 AA00 BA45 BA52 BA62 BB27
CD05 DA05 DC01 EA01 EA11
EA18
5K027 AA11 BB01 CC08 HH11
5K051 CC07 DD01 DD15 FF02 FF06
FF07 FF22 GG07 HH16
5K067 AA28 BB03 BB04 BE02 EE01
FF02 GG06 GG11 GG22 HH07
HH11 HH22 HH23